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Description

PISTON RING ASSEMBLY

FIELD OF INVENTION

[0001] The present invention relates to a piston ring assembly having an upper ring, a lower ring and an expander positioned therebetween, and more particularly to a piston ring assembly having an expander such that radial compression upon the upper and lower rings induces axial expansion of the expander.

BACKGROUND OF THE INVENTION

[0002] A piston reciprocates within a cylinder of an internal combustion engine and compresses fluids, such as gases, within a combustion chamber of the cylinder. These compressed fluids are then ignited to expand within the combustion chamber thereby forcing the piston away from the point of ignition and cycling the piston to its original position.

[0003] Piston ring assemblies are typically received within an annular groove disposed about an outer periphery of a pis-

ton. The primary function of piston ring assemblies is to provide an effective seal. This is typically accomplished by placing a first piston ring assembly, called a compression ring, near an uppermost portion of the piston. The compression ring is designed to seal during up-stroke of the piston to compress gases within the combustion chamber. Further, the piston ring assemblies also prevent excess lubricating oil from entering the combustion chamber during down-stroke of the piston. Typically, a second piston ring, called an oil ring, is placed below the compression ring to prevent oil from escaping into the combustion chamber.

[0004] Outer peripheries of the piston ring assemblies contact a wall of the cylinder to form the seal. As a result of manufacturing tolerances and material expansion due to heat generated by the engine, the fit of the piston ring assemblies within the grooves fluctuates. Accordingly, oil or combustion gases may still escape through a gap between the surfaces of the piston ring assembly and its associated groove. The escape of oil and combustion gases results in a less efficient engine.

[0005] Accordingly, there is a need for an improved piston ring assembly that increases engine efficiency by providing an

effective seal between not only the outer periphery of the piston ring assembly and the cylinder wall, but also between surfaces of the piston ring assembly and the associated annular groove of the piston.

BRIEF SUMMARY OF THE INVENTION

[0006] The present invention is directed to a piston ring assembly comprising an upper ring and a lower ring. An expander is positioned between the upper ring and the lower ring and includes apexes adapted to contact the upper ring and the lower ring, wherein radial compression applied to the upper and lower rings induces axial expansion of the expander.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] Figure 1 is an exploded view of a piston ring assembly of the present invention;

[0008] Figure 2 is a sectional perspective view of the piston ring assembly of the present invention;

[0009] Figure 3 is a sectional flat side view of an expander of the piston ring assembly when ends of the expander engage each other during radial compression of the expander;

[0010] Figure 4 is a partial cut-away cross-sectional view of the piston ring assembly while positioned within an annular

groove of a piston taken along the line 4-4 of Figure 2 while the expander is in a relaxed state; and

[0011] Figure 5 is a partial cut-away cross-sectional view of the piston ring assembly positioned within the annular groove of the piston taken along the line 5-5 of Figure 2 where the expander is in a compressed state.

DETAILED DESCRIPTION OF THE INVENTION

[0012] Referring now to Figures 1 and 2, a piston ring assembly of the present invention is shown generally at 10. The piston ring assembly 10 includes an upper ring 12 and a lower ring 14. The upper ring 12 includes a first shoulder recess 16 about an inner periphery while the lower ring 14 includes a second shoulder recess 18 about an inner periphery. When the upper and lower rings 12, 14 are mated, the first and second shoulder recesses 16, 18 define a cavity 20 therebetween. The piston ring assembly 10 also includes an expander 22 positioned between the upper and lower rings 12, 14 within the cavity 20.

[0013] Each of the rings 12, 14 includes a mating inner surface 24, 26, respectively. One of the mating inner surfaces 24, 26 of either the upper ring 12 or the lower ring 14 includes a plurality of projections 28. The projections 28, as illustrated in Figure 1, are included on the mating inner

surface 26 of the lower ring 14 and have a generally triangular shape in accordance with one embodiment of the present invention. As seen in Figure 2, when the piston ring assembly 10 is assembled the mating inner surfaces 24, 26 and plurality of projections 28 define a plurality of vents 30. The vents 30 alternate about the piston ring assembly 10 to allow oil to drain back through the piston ring assembly 10 into holes 32 in an annular ring groove 34 of a piston 36.

[0014] Again, as seen in Figure 1, the upper ring 12 includes a first ring gap 38, while the second ring 14 includes a second ring gap 40. The gaps 38, 40 are typically offset from each other when the rings 12, 14 are assembled into the piston ring assembly 10. Offsetting the gaps 38, 40 makes it more difficult for oil to pass through the piston ring assembly 10 and escape into the combustion chamber. As contemplated by the invention, the upper and lower rings 12, 14 are generally made of steel, cast iron or the like. However, any material contemplated by one skilled in the art may be utilized. Furthermore, the expander 22 also includes an expander gap 42. As illustrated in Figure 1, the expander gap 42 is also typically offset from the first and second ring gaps 38, 40 when

assembled into the piston ring assembly 10.

[0015] In accordance with one aspect of the invention, the expander 22 is generally sinusoidal in shape having alternating apexes 44, as shown in Figure 3. The alternating apexes 44, as illustrated, are generally flat surfaces. However, the apexes 44 may be of any shape such that the apexes 44 of the expander 22 are adapted to contact the upper and lower rings 12, 14 when positioned within the cavity 20. The illustrated embodiment of generally flat apexes 44 is not intended to be limiting. For example, the apexes 44 may be rounded or pointed.

[0016] Each apex 44 separates leg members 46a, 46b that define an angle A, with respect to each other. In the illustrated embodiment, the angle, A, is approximately sixteen (16) degrees. However, the invention can be practiced with other angles, A, to produce a desired amount of spring force exerted by the expander 22 against the upper and lower rings 12, 14. The expander 22 is generally made from stainless steel, however, any suitable material may be used as determined by one skilled in the art. The expander 22 also includes ends 47a, 47b that are substantially parallel to each other.

[0017] Referring now to Figure 4, the piston ring assembly 10 is

positioned within the annular ring groove 34 of the piston 36. The ring groove 34 has an upper surface 48 and a lower surface 50 at opposite ends of a base surface 52. The upper and lower surfaces 48, 50 of the ring groove 34 are proximate to the upper and lower rings 12, 14, respectively.

[0018] Figure 4 illustrates the piston ring assembly 10 when in a generally relaxed state. When positioned within the cavity 20, the expander 22 has a thickness greater than the width of the shoulder recesses 16, 18 such that a portion of the expander 22 extends radially outwardly from the upper and lower rings 12, 14 toward the base surface 52. In the relaxed state, although the expander 22 extends toward the base surface 52, contact between the inner periphery of the expander 22 and the base surface 52 of the piston is generally avoided. The diameter of the inner periphery of the expander 22 is generally larger than the outer diameter of the piston 36. Furthermore, in the relaxed state the apexes 44 of the expander 22 are in contact with the first and second shoulder recesses 16, 18. The contact between the apexes 44 and the shoulder recesses 16, 18, however, exerts only a minimal force upon the rings 12, 14.

[0019] As illustrated in Figures 4-5, the piston 36 reciprocates within a cylinder 54. The cylinder 54 has a cylinder wall 56 generally surrounding the piston 36. Each of the upper and lower rings 12, 14 of the piston ring assembly 10 includes a lip 58 extending about the outer periphery. When assembled, the lip 58 of each ring 12, 14 contacts the cylinder wall 56 to form a seal that prevents the escape of gases and oil during reciprocation of the piston 36.

[0020] As illustrated in Figure 4, in the relaxed state, passageways 60 are disposed between the piston ring assembly 10 and the upper, lower and base surfaces 48, 50, 52 of the ring groove 34. During the downstroke of the piston 36, oil may escape into the combustion chamber through the passageways 60. Accordingly, eliminating the passageways 60 will prevent the escape of oil into the combustion chamber, resulting in a more efficient engine.

[0021] In accordance with an embodiment of the invention, during the down stroke of the piston 36, compression is directed radially inward from the outer periphery of the piston ring assembly 10. The radial compression is applied to the upper and lower rings 12, 14 at the contact point between the lips 58 of each ring 12, 14 and the cylinder wall 56. The radial compression of the upper and lower

rings 12, 14 induces axial expansion of the expander 22, causing the two generally parallel ends 47a, 47b defining the expander gap 42 to mate to form a generally W-shaped configuration, shown generally at 62 in Figure 3. The W-shaped configuration 62 is only one example of mating the ends 47a, 47b of the expander gap 42 during compression. Any configuration to mate the ends 47a, 47b of the expander gap 42 that induces axial expansion of the expander 22 when the piston ring assembly 10 is subjected to radial compression is contemplated by the present invention. Additionally, the first and second ring gaps 38, 40 also narrow during radial compression of the piston ring assembly 10, but typically never completely close. The clearance remaining between the ends of each ring gap 38, 40 varies with the diameter of the piston 36, material properties and the force of radial compression.

[0022] As seen in Figure 5, upon further axial expansion the expander 22 buckles, resulting in an increased force between the alternating apexes 44 of the expander 22 and the first and second shoulder recesses 16, 18 of the upper and lower rings 12, 14. Accordingly, the upper ring 12 is urged against the upper surface 48 of the ring groove 34, while the lower ring is urged against the lower surface 50

of the ring groove 34. The passageways 60 previously existing between the piston ring assembly 10 and the upper and lower surfaces 48, 50 of the ring groove 34 are minimized or eliminated. Furthermore, the inner periphery of the expander 22 is pressed into contact with the piston 36, thereby eliminating the passageway 60 between the expander 22 and the base surface 52. Therefore, oil and gases are prevented from escaping between the piston ring assembly 10 and the ring groove 34 through the passageway 60, thereby resulting in a more effective seal than conventional ring assemblies.

[0023] It is to be understood that the above description is intended to be illustrative and not limiting. Many embodiments will be apparent to those of skill in the art upon reading the above description. Therefore, the scope of the invention should be determined, not with reference to the above description, but instead with reference to the appended claims, along with the full scope of equivalents to which such claims are entitled.